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THE NORTH-AMERICAN ARBOREAL SQUIRRELS.

J. A. ALLEN.

No attempt at a critical revision of the American arboreal squirrels has been made since 1878, but during the last two years several noteworthy contributions to this end have appeared, covering practically the Sciuri occurring north of Panama; but those of South America still await revision. The latest and by far the most important of these contributions is Mr. E. W. Nelson's recently published "Revision of the Squirrels of Mexico and Central America,"[1] which marks an epoch in the history of the subject. Mr. Nelson is not only a well-trained naturalist, but has several marked advantages over previous monographers in having at his command not only a far greater amount of material, but material incomparably better in character, and also an intimate acquaintance with the physiographic conditions of the region to which his studies relate, and with the animals themselves in life, gained through eight years' field experience in Mexico and Central America. He has not only thoroughly explored, in company with his assistant, Mr. E. A. Goldman, under the auspices of the United States Biological Survey of the Department of Agriculture, western Guatemala, but has traversed Mexico from sea to sea, and from north to south, on several different lines. Of the 919 specimens on which his monograph is based, more than 600 were collected by himself and assistant. During the preparation of his paper he was "able to examine representatives — and in most cases types or topotypes — of nearly all the known species and subspecies found in Mexico and Central America." The investigation, under such favorable conditions, of the large amount of excellent material at his disposal has led him to recognize 30 species and 13 subspecies as occurring between the southern boundary of the United States and Panama, of which four only extend north of this boundary. In 1877 and 1878 the number recognized, respectively, by Allen and Alston, in their well-known papers on the American Sciuri, was 9 and 7. Not only, however, was the material then available comparatively scanty and poor in quality, but, as Mr. Nelson observes, these authors "were handicapped by the prevailing tendency of the time to lump species."

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[1] *Proc. of the Washington Acad. of Sci.*, vol. i, pp. 15–106, Pls. I and II. Published May 9, 1899.

Under "Notes on Distribution and Variation" Mr. Nelson refers to the definiteness of the ranges of the various species, which is governed by the distribution of the different kinds of forest growth, which in turn is controlled by temperature and moisture.

In his review of the "Subgenera of North-American Species" Mr. Nelson recognizes 10 subgenera, of which four are here first characterized, namely, Baiosciurus, Aræosciurus, Otosciurus, and Hesperosciurus. Three of the 10 subgenera are practically confined to that portion of North America north of Mexico (one entirely so, and two others extending south of the United States only into northern Lower California); two are properly South American, while the remaining five are common to the United States and Mexico. These groups are characterized by differences in size and proportions, together with differences in the shape of the skull and in dentition, and seem to form natural groups, though in general but slightly differentiated. By far the greater part of the tropical forms (10 species and 13 subspecies) belong to the single subgenus Ehinosciurus, which is unrepresented north of Mexico.

According to Mr. Nelson: "Tree squirrels occur in suitable places throughout Mexico and Central America, but the distribution of the various species depends largely upon the character of the forests. Thus *Sciurus negligens* is most abundant in the low dense forests of ebony, less than twenty-five feet high, on the hot coast plains, while its near relative, *S. deppei*, loves the shady depths of the humid tropical forests on the lower mountain slopes where the damp air produces an exuberant tree growth and an abundance of parasitic plants. . . . The larger species exist under even more varied conditions, since they occur from the hot coast country to the region of oaks and pines close to timber line, but the ranges of different species or subspecies are never coincident and overlap only in a few instances, as in the case of *S. colliæi nuchalis* and *S. poliopus colimensis* on the coast of Colima, and *S. apache* and *S. durangi* in the Sierra Madre.

"Many species change their environment by periodical migrations in search of food, moving from one locality to another with the ripening of fruits or seeds upon which they subsist. This is most marked on high mountains, where a species may have a vertical range of many thousand feet." Mr. Nelson also says: "The effect of climate on the character of the pelage is so marked that it is possible to tell with considerable certainty whether a species belongs to the tropics or to the high mountains. Tropical species have thin pelage, short, thin under fur, and coarse, stiff, or almost bristly, dorsal hairs. . . . These differences are sometimes strikingly shown in subspecies of the same squirrel." Seasonal differences, however, are slight, but individual variation, on the other hand, is often excessive, rendering some species extremely difficult to describe.

"The extraordinary amount of geographical variation in tropical North-American squirrels is due mainly to an unusual plasticity of the organization which allows slight climatic differences to produce visible effects. The most obvious of these influences are differences in temperature and rainfall, with their distribution through the year and consequent effect on vegetation." Thus in the drier interior mountains certain subspecies of a group will be characterized by dull grayish upper parts and white under parts, while other subspecies of the same group inhabiting humid mountains near the coast will have nape and rump patches sharply contrasting with the rest of the dorsal surface and bright ferruginous under parts, increased humidity within the tropics being usually accompanied by increased intensity of coloration.

In this admirable paper Mr. Nelson attempted a most difficult task, which consisted in not only recognizing and defining the various forms of tree squirrels inhabiting tropical North America, but in clearing up the tangle of synonymy involved in the works of previous authors. As a first step to this result he identified as far as possible the type localities of all the species previously described, and secured from them "topotypes"; and he was further greatly aided by Mr. Oldfield Thomas, of the British Museum, in determining many of Gray's imperfectly described species. While it is too much to expect that Mr. Nelson's revision will be final, especially as regards the Central-American forms, his paper is of the highest importance as a contribution towards reducing to comparative order the chaos that has hitherto prevailed in this difficult field. As a result of his determinations several radical changes of nomenclature have been necessary, including the proper allocation of Erxleben's *Sciurus variegatus,* which has proved so great a source of trouble to previous writers, but which Mr. Nelson has conclusively shown belongs, not to any species of Sciurus, but to a species of Spermophilus! Great credit is due Mr. Nelson for his well-planned and intelligent work in the field, as well as for the careful elaboration of his material and the clear and workmanlike way in which he has presented his results.

In addition to Mr. Nelson's revision of the squirrels of tropical America, two recent contributions have been made to our knowledge of the squirrels of North America north of Mexico.

In December, 1896, Mr. Outram Bangs published "A Review of the Squirrels of Eastern North America,"[1] which included the flying squirrels as well as the ordinary tree squirrels. This paper gave, under the genus Sciurus, four species and six subspecies, three of the latter being described as new, to which Mr. Bangs has since added another subspecies.[2]

The squirrels of western North America have not, as a whole, been recently revised, although much has been incidentally written about them, and several new forms have been described. The chickarees, or red squirrels (subgenus Tamiasciurus), were recently monographed by the present writer.[3] In this paper four species and 13 additional subspecies were recognized, four of the latter being described as new.

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[1] *Proc. Biol. Soc. Wash.*, vol. x, pp. 145–167. Published Dec. 28, 1896.

[2] Sciurus (Tamiasciurus) gymnicus, *Proc. N. Engl. Zoöl. Club*, vol. i, p. 28. Published March 31, 1899.

[3] Allen, J. A. Revision of the Chickarees, or North-American Red Squirrels (subgenus Tamiasciurus), *Bull. Am. Mus. Nat. Hist.*, vol. x (1898), pp. 249–298. Published July 22, 1898.

The last complete revision of the arboreal squirrels of North America north of Mexico was made in 1877,[1] when six species and seven additional subspecies were recognized. Since that date not only has a large number of new forms been added and important changes in nomenclature been made, but the point of view has become radically changed through the accumulation of a vast amount of additional and far better material than was available twenty years ago. In consequence of this it may be a convenience to those interested in our mammals to give in this connection a list of the 10 species and 25 additional subspecies of arboreal squirrels, now recognized by experts as found north of Mexico, with a brief statement of their ranges.

Arboreal Squirrels Found in North America North of Mexico.

SUBGENUS HESPEROSCIURUS NELSON.

1. *Sciurus griseus* Ord. California gray squirrel. Southwestern Washington, western Oregon, and California.
1*a*. *Sciurus griseus nigripes* (Bryant). Coast region of California south of San Francisco.
1*b*. *Sciurus griseus anthonyi* Mearns. Anthony's gray squirrel. Interior of southern and lower California.

SUBGENUS NEOSCIURUS TROUESS.

2. *Sciurus carolinensis* Gmel. Southern gray squirrel. Eastern United States, from southern New York to northern Florida.
2*a*. *Sciurus carolinensis leucotis* (Gapper). Northern gray squirrel. Northern Alleghanies, and northward to New Brunswick and southern Canada.
2*b*. *Sciurus carolinensis hypophæus* Merriam. Merriam's gray squirrel. Minnesota and Wisconsin.
2*c*. *Sciurus carolinensis fuliginosus* (Bachman). Bayou gray squirrel. Coast region of Louisiana.
2*d*. *Sciurus carolinensis extimus* Bangs. Southern half of Florida.

SUBGENUS OTOSCIURUS NELSON.

3. *Sciurus aberti* Woodhouse. Abert's squirrel. Mountains of Colorado, New Mexico, and Arizona.
3*a*. *Sciurus aberti concolor* True. Northeastern Colorado.

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[1] Allen, J. A. *Monog. N. Am. Roden.* (1877), pp. 633–778, *passim*.

SUBGENUS PARASCIURUS TROUESS.

4. *Sciurus niger* Linn. Southern fox squirrel. Virginia to southern Florida, east of the Alleghanies, and along the Gulf coast to eastern Louisiana.
5. *Sciurus ludovicianus* Custis. Western fox squirrel. Mississippi Valley, from Louisiana to Michigan, and from the western edge of the Alleghanies to the eastern border of the Plains.
5*a*. *Sciurus ludovicianus vicinus* Bangs. Northern fox squirrel. Mountains of West Virginia northward into western Pennsylvania. Formerly from northern Virginia north to southern New York and southern New England; now extirpated, except at the localities above indicated.
5*b*. *Sciurus ludovicianus limitis* (Baird). Texas fox squirrel. Texas, south into northeastern Mexico.

SUBGENUS ARÆOSCIURUS NELSON.

6. *Sciurus apache* Allen. Apache squirrel. Chiricahua Mountains, Arizona, south into Mexico in the Sierra Madre to Durango.
7. *Sciurus arizonensis* Coues. Arizona squirrel. Mountains of central Arizona.
7*a*. *Sciurus arizonensis huachuca* Allen. Huachuca squirrel. Huachuca Mountains, southern Arizona, south into Sonora.

SUBGENUS TAMIASCIURUS TROUESS.

8. *Sciurus hudsonicus* (Erxl.) Northern chickaree. Canada, north of Ontario and Quebec, east of the Rocky Mountains, and Alaska.
8*a*. *Sciurus hudsonicus gymnicus* Bangs. Northern New England, northern New York, and southern Canada, including New Brunswick, Nova Scotia, Quebec, and Ontario.
8*b*. *Sciurus hudsonicus loquax* Bangs. Southern chickaree. From southern New England, southern New York, and the vicinity of the Great Lakes, south to Virginia, and in the Alleghanies to North Carolina.
8*c*. *Sciurus hudsonicus minnesota*, subsp. nov.[1] Minnesota chickaree.

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[1] In my revision of the chickarees (*loc. cit.*) I called special attention to the small size of the chickarees examined from New Hampshire, northern Maine, New Brunswick, and Nova Scotia, and the large size of those from southern Minnesota and Wisconsin, these two phases presenting the extremes in size among the chickarees of eastern North America. They also differ a little in color when series of the two forms are compared, the small Eastern one being somewhat darker than the large Western one. As, however, they grade so insensibly into the Southern (*S. h. loquax*) and Northern (true *S. hudsonicus*) chickarees, respectively, it then seemed to me not worth while to recognize in nomenclature forms so hard to define, either in physical characteristics or geographically. Now that

Minnesota and Wisconsin, and probably Iowa, and eastward to northern Indiana.

8*d*. *Sciurus hudsonicus dakotensis* Allen. Black Hills chickaree. Black Hills, South Dakota, and adjoining portions of Wyoming.

8*e*. *Sciurus hudsonicus baileyi* Allen. Bailey's chickaree. Mountains of central Wyoming and eastern Montana, and northward into Alberta.

8*f*. *Sciurus hudsonicus ventorum* Allen. Wind River Mountains chickaree. Wind River Mountains and northward along the eastern base of the Rocky Mountains in Montana.

8*g*. *Sciurus hudsonicus richardsonii* (Bachman). Richardson's chickaree. Western border of northern Montana, central and northern Idaho, northeastern Washington, and northward into southeastern British Columbia.

8*h*. *Sciurus hudsonicus streatori* Allen. Streator's chickaree. From the central part of northern Washington northward over central British Columbia.

8*i*. *Sciurus hudsonicus vancouverensis* Allen. Vancouver chickaree. Vancouver Island, and northward along the coast to Sitka.

9. *Sciurus douglasii* Bachman. Douglas's chickaree. Coast region of Oregon and Washington.

9*a*. *Sciurus douglasii mollipilosus* (Aud. & Bach). Redwood chickaree. Coast region of northern California (=*Sciurus hudsonicus orarius* Bangs, 1897).

9*b*. *Sciurus douglasii cascadensis* Allen. Cascades chickaree. The Cascades region of Oregon and Washington, north into British Columbia.

Mr. Bangs has given a name to the small Eastern form, and left under *S. h. loquax* the large Minnesota one, it seems admissible, and perhaps advisable, to also name the large Western form.

Mr. Bangs has defined his *S. h. gymnicus* as: "Size smallest; hind foot small; colors all very dark," etc. He gives the size as: "Total length, 300; tail vertebræ, 117; hind foot, 47 mm."

S. h. minnesota may be characterized as size largest of the Eastern chickarees; hind foot large; colors lighter, etc. Total length, 345; tail vertebræ, 143; hind foot, 50 mm. Type, No. 4374, *Am. Mus. Nat. Hist.*, ♀ ad., Fort Snelling, Minn., April 4, 1890. Collected and presented by Dr. Edgar A. Mearns.

Mr. Bangs gives the average measurements of 6 adult topotypes of his *S. h. gymnicus* as: "Total length, 290.2; tail vertebræ, 121.2; hind foot, 44.5 mm. The measurements of 20 topotypes of *S. h. minnesota* measure: Total length, 334; tail vertebræ, 130.2; hind foot, 49.2 mm.

Mr. Bangs also gives the average measurements of 10 adults of *S. h. gymnicus* from Digby, Nova Scotia, presumably from his own collection, which by a singular coincidence agree to a millimeter in all the measurements with a series of the *same number* of specimens, from the *same locality*, given by me in my paper on the chickarees (*loc. cit.*), published nine months earlier.

In comparison with *S. h. loquax* the Minnesota form is as much larger than *S. h. loquax* as *S. h. gymnicus* is smaller, while the color differences are quite as tangible.

9*c*. *Sciurus douglasii albolimbatus* Allen. California chickaree. Sierra Nevada region of California, north into Oregon, east of the Cascades (= *Sciurus hudsonicus californicus* Allen, 1890).

9*d*. *Sciurus douglasii mearnsi* (Townsend). Mearns's chickaree. San Pedro Martir Mountains, Lower California.

10. *Sciurus fremonti* Aud. & Bach. Fremont's chickaree. Mountains of Colorado, north to the southern border of Wyoming, and west to the Uinta Mountains.

10*a*. *Sciurus fremonti neomexicanus* Allen. Taos chickaree. New Mexico.

10*b*. *Sciurus fremonti mogollonensis* (Mearns). Arizona chickaree. Mountains and higher plateaus of central Arizona.

As shown above, the subgenus Hesperosciurus is represented by a single species and an additional subspecies; the subgenus Neosciurus is also represented by a single species with four additional subspecies; the subgenus Otosciurus has a single species and an additional subspecies in the United States, and a second species in Mexico; the subgenus Parasciurus has two species and two additional subspecies; the subgenus Aræosciurus has two species and an additional subspecies in the United States, and three additional species and one subspecies in Mexico; Tamiasciurus has three species and 15 additional subspecies.

All the *species* of North-American Sciuri are sharply differentiated; the numerous *subspecies* represent for the most part well-marked geographical forms, which characterize more or less natural physiographic areas. In many cases the subspecies, in their extreme phases of development, are strongly differentiated, yet coalesce so completely at intermediate points as to be unsusceptible of sharp definition. They, however, represent stages in the evolution of species, and are facts that may be conveniently made note of by the brief formula of a trinomial name.